PALEOMAGNETISM

Introduction

Shipboard paleomagnetic scientists provided the first paleomagnetic analyses of sediments and rocks recovered by the Ocean Drilling Program (ODP). This information was used by shipboard and shore-based scientists as the basis for further sampling and study, and for forming the first general conclusions about the geologic history of the drilling site. The shipboard Paleomagnetics Laboratory contained state-of-the-art equipment that allowed scientists to perform detailed studies.

Main objectives for collecting paleomagnetic data included:

1. Magnetostratigraphy, the magnetic polarity time scale and correlation techniques;
2. Behavior of the geomagnetic field, polarity intervals, polarity transitions, and reversals;
3. Tectonics of the ocean basins, motions of the crustal plates and paths of the wandering poles;
4. Provide information about the oceanic crust – origin of anomalies, ridge processes, old crust, seamounts.

Data Acquisition

Most of the paleomagnetic data (PMAG) were collected with 2G Enterprises 760-R three-axis, pass-through cryogenic (superconducting) magnetometers. The 2G was equipped with an alternating-field (AF) demagnetizer in-line with the cryogenic magnetometer that would allow demagnetization and measurement of the remanent field on the same run. Normally, archive-half sections were run for natural remanence magnetization (NRM), then at least one demagnetization step. Archive sections were typically not subjected to fields higher that 20 milliTesla (mT) early in the ODP, but after September 1992 (Leg 147), the ODP panel overseeing scientific data collection agreed to allow the Shipboard Scientific Parties to partially demagnetize the core as high as necessary in an effort to remove drilling-induced overprint and isolate the characteristic remanence.

There were several changes in the PMAG data acquisition and data analysis software. A series of independently written programs were used. Some of the programs were created under severe time constraints. Several programs may have been available to a Shipboard Scientific Party, but there was no single preferential program defined for the analysis of the data. After a new 2G 760R magnetometer was installed during the Leg 168 port call and the Janus database became operational on Leg 171, a new version of the data acquisition software was deployed at the end of Leg 172. This new program created a data file with the parameters that had been built into the Janus database.

In addition to the long-core measurements, the Paleomagnetism Laboratory on the *JOIDES Resolution* was equipped with a wide range of equipment that could be used for detailed studies of discrete samples. The equipment that was available included:

- magnetometers - 2G 760-R cryogenic, Molspin Minispin spinner, Schonstedt Portable Three-Axis Fluxgate, and a Hall-effect MG-5D;
- demagnetizers – Schonstedt Alternating Field Demagnetizer Model GSD-1 and Schonstedt Thermal Demagnetizer, Model TSD-1, DTECH Model D2000;
- rock-magnetic equipment - Bartington susceptibility meters, Kappabridge KLY-2 Magnetic Susceptibility System for measuring anisotropy, ASC Impulse Magnetizer for measuring isothermal remanence magnetization (IRM) and anisotropy of IRM, DTECH Partial Anhysteretic Remanent Magnetizer (PARM).

Discrete samples could be demagnetized in much higher fields or by other methods and run through the cryogenic magnetometer to measure the resulting fields.

Core Orientation Tools and Data

One of the methods to help paleomagnetic scientists determine the ambient magnetic field was to measure the orientation of the core both vertically and horizontally. Two tools were used to collect core orientation data: the Eastman-Whipstock Multishot tool and the Tensor multishot tool. The older multishot tool was used during APC core drilling, required a special non-magnetic drill collar, and orientation data were recorded on 10-mm movie film. The newer tensor tool still required a non-magnetic drill collar, but could be used even during rotary core drilling, and collected the data from three magnetometers and twos accelerometers digitally. The tensor data acquisition and analysis software was a significant improvement for determining core orientation. After Janus became operational, an analysis program was developed that uploaded the analyzed data directly into the database.

Archive

Pre-Janus Archive

Paleomagnetic data were stored in an S1032 data through Leg 129. Starting with Leg 130, data were written to files which were sent back to ODP/TAMU at the end of each cruise and archived on servers. Logsheets were used to keep track of the analyses of sections and discrete samples. The logsheets were sent back to shore to be microfilmed for archival storage.

Migration of PMAG data to Janus

The data model for Paleomagnetic data can be found in Appendix I. Included are the relational diagram and the list of the tables that contain data pertinent to PMAG

analyses, the column names and the definition of each column attribute. ODP Information Services Database Group was responsible for the migration of pre-Leg 171 data to Janus.

The discrete paleomagnetic data collected by shipboard paleomagnetic scientists were not migrated to the Janus database. Although data exist for the discrete sample analyses, the treatments that were applied to the samples were not well documented. It would require a significant amount of time to research each of the discrete analyses, to determine whether the sample was just demagnetized in a higher intensity alternating field, or thermally demagnetized, or other treatments such as ARM or IRM.

Janus Paleomagnetic Data Format

Most of the continuous paleomagnetic data are available through the Janus web query Cryomagnetometer. The Cryogenic Magnetometer query webpage allows the user to extract data using the following variables to restrict the amount of data retrieved: leg, site, hole, core, section, depth range, or latitude and longitude ranges. In addition, the PMAG query gives the user options of retrieving data by treatment type, demagnetization level, core geometry (archive or working half, whole core, etc.), continuous or discrete analyses only, and excluding a user-defined interval of the ends of the sections.

Table 1 lists the data fields retrieved from the Janus database for the predefined PMAG query. The first column contains the data item; the second column indicates the Janus table or tables in which the data were stored; the third column is the Janus column name or the calculation used to produce the value. Appendix II contains additional information about the fields retrieved using the Janus Web Cryomagnetometer query, and the data format for the archived ASCII files.

Some of the post-Leg 172 discrete sample data are also available. These discrete data have the same problem as the pre-Leg 172 discrete data – the treatments applied to the samples were not well documented.

The Janus data model was modified to allow more formal documention of discrete sample analyses. The treatments often used for studies on discrete samples were added so that scientists could document in the data file the treatment and demagnetization level without needing to put that information into a comment field. The changed database was deployed on Leg 191.

Although the post-Leg 172 uncorrected paleomagnetic intensity and uncorrected and corrected moment data are in the Janus database, the query currently does not have an option of retrieving those data. For additional information, contact the ODP-TAMU Data Librarian. Additional information about ODP Paleomagnetic data measurements can be found in *Technical Note 18: Handbook for Shipboard Paleomagnetists.*

Table 1. Cryogenic Magnetometer

Item Name	Janus Table	Janus Column Name and Calculation
Leg	SECTION	Leg
Site	SECTION	Site
Hole	SECTION	Hole
Core	SECTION	Core
Type	SECTION	Core_type
Section	SECTION	Section_number
Top (cm)	PMAG_SECTION_DATA	PMAG_top_interval x 100
Depth (mbsf)	DEPTH_MAP, PMAG_SECTION_DATA	DEPTH_MAP.map_interval_top + PMAG_SECTION_DATA.PMAG_top_interval
Treatment	PMAG_TREATMENT_TYPE	PMAG_treatment_type
Treatment Demag Level	PMAG_SECTION_DATA	PMAG_treatment_demag
Demag type	PMAG_DEMAG_TYPE	PMAG_demag_type
Demag level	PMAG_SECTION_DATA	PMAG_demag_level
Declination	PMAG_SECTION_DATA	PMAG_declination
Inclination	PMAG_SECTION_DATA	PMAG_inclination
Intensity	PMAG_SECTION_DATA	PMAG_intensity
Hole Inclination	TENSOR_TOOL_RESULTS	Hole_inclination
Intensity X	PMAG_RUN_DATA	PMAG_corr_intensity_x
Intensity Y	PMAG_RUN_DATA	PMAG_corr_intensity_y
Intensity Z	PMAG_RUN_DATA	PMAG_corr_intensity_z
Run Number	PMAG_SECTION_DATA	PMAG_run_num
Comment	PMAG_RUN	PMAG_comment

Data Quality

A tremendous amount of paleomagnetics data were collected by shipboard scientists during the ODP. Almost 7.4 million measurements were made on cores recovered on 94 legs (discrete analyses not included), with over 5 million of those measurement made since Leg 172 when the Janus database was operational and the new 2G Enterprises 760R magnetometer had been deployed. These numbers reflect the stabilization of PMAG data collection that allowed scientists to collect higher density measurements on sections and more reliable analytical tools for the analyses of data.

There are several things that can affect the quality of PMAG data. Type of cored material and the drilling method used to recover the core are major factors. Hydraulic piston coring (APC, coretype H) used to recover softer, undisturbed sediments will routinely give the best results because the core liner is usually full. However, the sediments can also contain a lot of gas which will create voids in the cored material. Cores cut by XCB and RCB are often biscuits surrounded by drilling mud or irregularly-shaped pieces. Voids, smaller diameter core, irregular pieces, thin runny mud will all affect the quality of the measurements.

Operator error may also be a source of errors. Throughout the ODP, the operator manually entered core information into the data acquisition program. Typographical

errors or entering wrong information occasionally happened, and some mistakes were not identified. Sometimes, the scientific party noticed the error and corrected it for the data included in the Initial Report volume, but the original files did not get corrected. A lot of effort during verification of PMAG data has gone into finding sections that may have been misidentified or the demagnetization level was wrong. Scientists used logsheets to document what was being analyzed. The logsheets did not routinely get returned to ODP/TAMU until Leg 181. They were very helpful when analyses were properly documented. When no logsheets were available, some of the techniques listed below were helpful in finding errors. Some runs have been renamed to different sections, but the evidence for misidentification had to be conclusive. Listed below are some of the clues used to find incorrectly identified analyses:

- two runs for a section, no run for the following section;
- run numbers out of sequence;
- nature of the core material – length of core, voids or less than full liners;
- two runs for a section, run numbers out of sequence, but same demag level. Section where run number would be in sequence missing that demag level run.

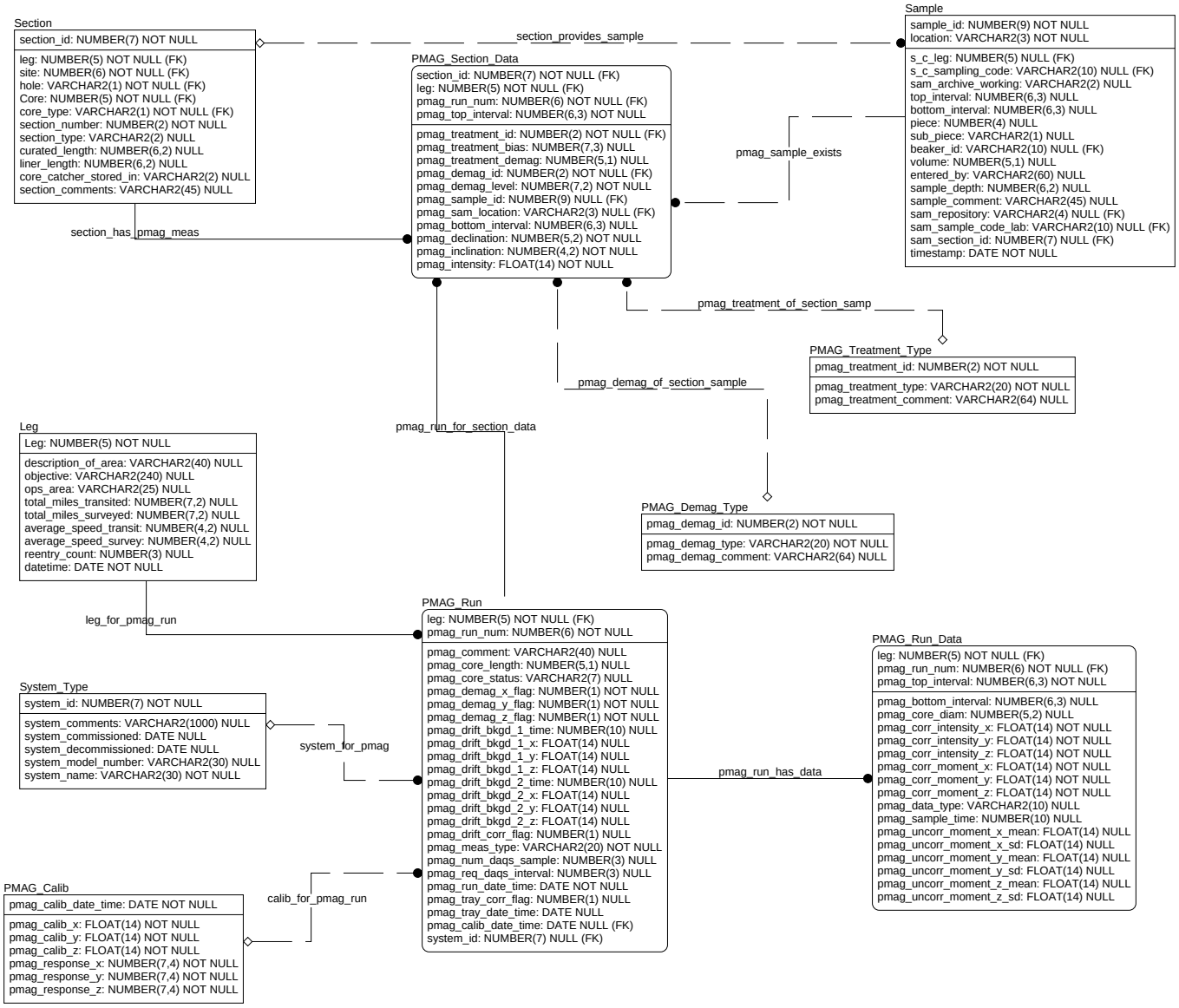
ODP Technical Note 18 has an extensive discussion of some of the other problems with paleomagnetic data collection. This technical note is available over the Internet. Unfortunately, there is no current technical note that describes paleomagnetic data collection since the Janus database became operational.

Although the Janus data model and the data acquisition program allow better documentation of discrete sample analyses, most of the post-Leg 191 discrete sample data files did not contain the treatment information. It is not known whether there was a problem with the data acquisition code not writing that information in the file, or whether the scientists did not use the tools in the data acquisition program setup to add that information.

References

Shipboard Scientific Party, 1998. Explanatory Notes. *In* Keigwin, L.D., Rio, D., Action, G.D., et al., 1998, *Proc. ODP Init. Repts*., 172: College Station, TX (Ocean Drilling Program), p. 13-29.

Stokking, L., Bontempo, D., Musgrave, R., Autio, W., 1993. Handbook for Shipboard Paleomagnetists, ODP Tech. Note 18.


Section
section_id: NUMBER(7) NOT NULL
leg: NUMBER(5) NOT NULL (FK)
site: NUMBER(6) NOT NULL (FK)
hole: VARCHAR2(1) NOT NULL (FK)
Core: NUMBER(5) NOT NULL (FK)
core_type: VARCHAR2(1) NOT NULL (FK)
section_number: NUMBER(2) NOT NULL
section_type: VARCHAR2(2) NULL
curated_length: NUMBER(6,2) NULL
liner_length: NUMBER(6,2) NULL
core_catcher_stored_in: VARCHAR2(2) NULL
section_comments: VARCHAR2(45) NULL
section_provides_sample
Sample
sample_id: NUMBER(9) NOT NULL
location: VARCHAR2(3) NOT NULL
s_c_leg: NUMBER(5) NULL (FK)
s_c_sampling_code: VARCHAR2(10) NULL (FK)
sam_archive_working: VARCHAR2(2) NULL
top_interval: NUMBER(6,3) NULL
bottom_interval: NUMBER(6,3) NULL
piece: NUMBER(4) NULL
sub_piece: VARCHAR2(1) NULL
beaker_id: VARCHAR2(10) NULL (FK)
volume: NUMBER(5,1) NULL
entered_by: VARCHAR2(60) NULL
sample_depth: NUMBER(6,2) NULL
sample_comment: VARCHAR2(45) NULL
sam_repository: VARCHAR2(4) NULL (FK)
sam_sample_code_lab: VARCHAR2(10) NULL (FK)
sam_section_id: NUMBER(7) NULL (FK)
timestamp: DATE NOT NULL
PMAG_Section_Data
section_id: NUMBER(7) NOT NULL (FK)
leg: NUMBER(5) NOT NULL (FK)
pmag_run_num: NUMBER(6) NOT NULL (FK)
pmag_top_interval: NUMBER(6,3) NOT NULL
pmag_treatment_id: NUMBER(2) NOT NULL (FK)
pmag_treatment_bias: NUMBER(7,3) NULL
pmag_treatment_demag: NUMBER(5,1) NULL
pmag_demag_id: NUMBER(2) NOT NULL (FK)
pmag_demag_level: NUMBER(7,2) NOT NULL
pmag_sample_id: NUMBER(9) NULL (FK)
pmag_sam_location: VARCHAR2(3) NULL (FK)
pmag_bottom_interval: NUMBER(6,3) NULL
pmag_declination: NUMBER(5,2) NOT NULL
pmag_inclination: NUMBER(4,2) NOT NULL
pmag_intensity: FLOAT(14) NOT NULL
pmag_sample_exists
section_has_pmag_meas
pmag_treatment_of_section_samp
PMAG_Treatment_Type
pmag_treatment_id: NUMBER(2) NOT NULL
pmag_treatment_type: VARCHAR2(20) NOT NULL
pmag_treatment_comment: VARCHAR2(64) NULL
pmag_demag_of_section_sample
pmag_run_for_section_data
Leg
Leg: NUMBER(5) NOT NULL
description_of_area: VARCHAR2(40) NULL
objective: VARCHAR2(240) NULL
ops_area: VARCHAR2(25) NULL
total_miles_transited: NUMBER(7,2) NULL
total_miles_surveyed: NUMBER(7,2) NULL
average_speed_transit: NUMBER(4,2) NULL
average_speed_survey: NUMBER(4,2) NULL
reentry_count: NUMBER(3) NULL
datetime: DATE NOT NULL
PMAG_Demag_Type
pmag_demag_id: NUMBER(2) NOT NULL
pmag_demag_type: VARCHAR2(20) NOT NULL
pmag_demag_comment: VARCHAR2(64) NULL
leg_for_pmag_run
PMAG_Run
leg: NUMBER(5) NOT NULL (FK)
pmag_run_num: NUMBER(6) NOT NULL
pmag_comment: VARCHAR2(40) NULL
pmag_core_length: NUMBER(5,1) NULL
pmag_core_status: VARCHAR2(7) NULL
pmag_demag_x_flag: NUMBER(1) NOT NULL
pmag_demag_y_flag: NUMBER(1) NOT NULL
pmag_demag_z_flag: NUMBER(1) NOT NULL
pmag_drift_bkgd_1_time: NUMBER(10) NULL
pmag_drift_bkgd_1_x: FLOAT(14) NULL
pmag_drift_bkgd_1_y: FLOAT(14) NULL
pmag_drift_bkgd_1_z: FLOAT(14) NULL
pmag_drift_bkgd_2_time: NUMBER(10) NULL
pmag_drift_bkgd_2_x: FLOAT(14) NULL
pmag_drift_bkgd_2_y: FLOAT(14) NULL
pmag_drift_bkgd_2_z: FLOAT(14) NULL
pmag_drift_corr_flag: NUMBER(1) NULL
pmag_meas_type: VARCHAR2(20) NOT NULL
pmag_num_daqs_sample: NUMBER(3) NULL
pmag_req_daqs_interval: NUMBER(3) NULL
pmag_run_date_time: DATE NOT NULL
pmag_tray_corr_flag: NUMBER(1) NULL
pmag_tray_date_time: DATE NULL
pmag_calib_date_time: DATE NULL (FK)
system_id: NUMBER(7) NULL (FK)
PMAG_Run_Data
leg: NUMBER(5) NOT NULL (FK)
pmag_run_num: NUMBER(6) NOT NULL (FK)
pmag_top_interval: NUMBER(6,3) NOT NULL
pmag_bottom_interval: NUMBER(6,3) NULL
pmag_core_diam: NUMBER(5,2) NULL
pmag_corr_intensity_x: FLOAT(14) NOT NULL
pmag_corr_intensity_y: FLOAT(14) NOT NULL
pmag_corr_intensity_z: FLOAT(14) NOT NULL
pmag_corr_moment_x: FLOAT(14) NOT NULL
pmag_corr_moment_y: FLOAT(14) NOT NULL
pmag_corr_moment_z: FLOAT(14) NOT NULL
pmag_data_type: VARCHAR2(10) NULL
pmag_sample_time: NUMBER(10) NULL
pmag_uncorr_moment_x_mean: FLOAT(14) NULL
pmag_uncorr_moment_x_sd: FLOAT(14) NULL
pmag_uncorr_moment_y_mean: FLOAT(14) NULL
pmag_uncorr_moment_y_sd: FLOAT(14) NULL
pmag_uncorr_moment_z_mean: FLOAT(14) NULL
pmag_uncorr_moment_z_sd: FLOAT(14) NULL
pmag_run_has_data
System_Type
system_id: NUMBER(7) NOT NULL
system_comments: VARCHAR2(1000) NULL
system_commissioned: DATE NULL
system_decommissioned: DATE NULL
system_model_number: VARCHAR2(30) NULL
system_name: VARCHAR2(30) NOT NULL
system_for_pmag
PMAG_Calib
pmag_calib_date_time: DATE NOT NULL
pmag_calib_x: FLOAT(14) NOT NULL
pmag_calib_y: FLOAT(14) NOT NULL
pmag_calib_z: FLOAT(14) NOT NULL
pmag_response_x: NUMBER(7,4) NOT NULL
pmag_response_y: NUMBER(7,4) NOT NULL
pmag_response_z: NUMBER(7,4) NOT NULL
calib_for_pmag_run

APPENDIX 1. Janus Data Model – Paleomagnetics - PMAG

Paleomagnetics – PMAG		
Table Name	**Column Name**	**Column Comment**
PMAG_Section_Data	section_id	Unique Oracle-generated sequence number to identify each section.
	leg	Number identifying the cruise for which data were entered into the database.
	pmag_run_num	Number identifying a run generated by the data acquisition software. Must be unique for a leg.
	pmag_top_interval	Top interval of a measurement in meters measured from the top of a section. Interval can extend 15 cm before and after section for header and trailer measurements.
	pmag_treatment_id	Unique Oracle-generated sequence number for each treatment type.
	pmag_treatment_bias	Values expected for ARM between 0.000 to 1,000 mT and for IRM between 1.0 to 3000.0 mT.
	pmag_treatment_demag	Values expected between 0.0 to 9999.9 mT.
	pmag_demag_id	Unique Oracle-generated sequence number for each demagnetization type.
	pmag_demag_level	Level of demagnetization: AF -- in mT, or thermal – ^{o}C.
	pmag_sample_id	Oracle-generated sequence number that with pmag_sam_location uniquely identifies a sample.
	pmag_sam_location	Code that indicates the site where the Janus application is exercised. Used with pmag_sample_id to uniquely identify a sample.
	pmag_bottom_interval	Bottom interval of a measurement in meters measured from the top of a section. Interval can extend 15 cm before and after the section for the header and trailer measurements.
	pmag_declination	Orientation of the magnetic field of the sample (the field acquired at the time of the rock formation) - the angle between geographic north and the magnetic field direction (the magnetic azimuth).
	pmag_inclination	Orientation of the magnetic field of the sample (the field acquired at the time of the rock formation) - the angle between the horizontal and the field direction measured positive downward.
	pmag_intensity	Intensity of the paleomag measurement, in Amperes/meter.
PMAG_Run	leg	Number identifying the cruise for which data were entered into the database.
	pmag_run_num	Number identifying a run generated by the data acquisition software. Must be unique for a leg.
	pmag_comment	Comment about section, sample, measurement or alternate treatment.
	pmag_core_length	Length of section analyzed. Does not have to match the curated length of the section.
	pmag_core_status	Status of section measured. Valid values are WHOLE, ARCHIVE (archive half) or WORKING (working half).
	pmag_demag_x_flag	Indicator whether section or sample demagnetized in x-direction. Valid values: 0 – no drift correction, 1 – drift correction.
	pmag_demag_y_flag	Indicator whether section or sample demagnetized in y-direction. Valid values: 0 – no drift correction, 1 – drift correction.
	pmag_demag_z_flag	Indicator whether section or sample demagnetized in z-direction. Valid values: 0 – no drift correction, 1 – drift correction.
	pmag_drift_bkgd_1_time	Time of first background measurement, will usually be zero, in milliseconds.
	pmag_drift_bkgd_1_x	The moment of the first background measurement in the x direction, in Amp m^2.
	pmag_drift_bkgd_1_y	The moment of the first background measurement in the y direction, in Amp m^2.
	pmag_drift_bkgd_1_z	The moment of the first background measurement in the z direction, in Amp m^2.
	pmag_drift_bkgd_2_time	The time that the second background measurement was taken, in milliseconds.
	pmag_drift_bkgd_2_x	The moment of the second background measurement in the x direction, in Amp m^2.
	pmag_drift_bkgd_2_y	The moment of the second background measurement in the y direction, in Amp m^2.
	pmag_drift_bkgd_2_z	The moment of the second background measurement in the z direction, in Amp m^2.

Paleomagnetics – PMAG		
Table Name	**Column Name**	**Column Comment**
	pmag_drift_corr_flag	Indicator if drift correction made. Valid values: 0 – no drift correction, 1 – drift correction.
	pmag_meas_type	Defines the measurement type. CONTINUOUS measurements are taken on a section; DISCRETE measurements are taken on a sample, piece or at a discrete location on a section.
	pmag_num_daqs_sample	Number of data measurements taken per sample interval.
	pmag_req_daqs_interval	Data acquisition interval requested for section analysis, in centimeters.
	pmag_run_date_time	Timestamp when analysis was run.
	pmag_tray_corr_flag	Indicator if tray correction done.
	pmag_tray_date_time	Timestamp of tray calibration.
	pmag_calib_date_time	The time that the SQUIDS on the magnetometer were calibrated or replaced.
	system_id	Unique identifier for a system of equipment on the ship
PMAG_Run_Data	leg	Number identifying the cruise for which data were entered into the database.
	pmag_run_num	Number identifying a run generated by the data acquisition software. Must be unique for a leg.
	pmag_top_interval	Top interval of a measurement in meters measured from the top of a section. Interval can extend 15 cm before and after section for header and trailer measurements.
	pmag_bottom_interval	Bottom interval of a measurement in meters measured from the top of a section. Interval can extend 15 cm before and after the section for the header and trailer measurements.
	pmag_core_diam	Diameter of the core at the pmag measurement position (in centimeters) - relevant only for CONTINUOUS measurement.
	pmag_corr_intensity_x	Intensity in the x direction that has been corrected for background and/or tray correction, in Amps/m.
	pmag_corr_intensity_y	Intensity in the y direction that has been corrected for background and/or tray correction, in Amps/m.
	pmag_corr_intensity_z	Intensity in the z direction that has been corrected for background and/or tray correction, in Amps/m.
	pmag_corr_moment_x	Intensity times volume in the x direction, in Amp m^2.
	pmag_corr_moment_y	Intensity times volume in the y direction, in Amp m^2.
	pmag_corr_moment_z	Intensity times volume in the z direction, in Amp m^2.
	pmag_data_type	Indicates data type. Valid values: CORE – normal core measurement; LEADER – measurement taken before top of section; TRAILER - measurement taken after end of section. Leader and Trailer are valid only for continuous measurements.
	pmag_sample_time	Time elapsed since background measurement, in milliseconds. For drift correction.
	pmag_uncorr_moment_x_mean	Mean of the uncorrected moment in the x direction, not corrected for tray and/or background, in Amp m^2.
	pmag_uncorr_moment_x_sd	Standard deviation of the uncorrected moment in the x direction.
	pmag_uncorr_moment_y_mean	Mean of the uncorrected moment in the y direction, not corrected for tray and/or background, in Amp m^2.
	pmag_uncorr_moment_y_sd	Standard deviation of the uncorrected moment in the y direction.
	pmag_uncorr_moment_z_mean	Mean of the uncorrected moment in the z-direction, not corrected for background and/or tray measurement. In Amp m^2.
	pmag_uncorr_moment_z_sd	Standard deviation of the uncorrected moment in the z direction.
PMAG_Calib	pmag_calib_date_time	The time that the SQUIDS on the magnetometer were calibrated or replaced.
	pmag_calib_x	This converts quantum flux to emu (emu/flux quantum units) in the x direction.
	pmag_calib_y	This converts quantum flux to emu (emu/flux quantum units) in the y direction.
	pmag_calib_z	This converts quantum flux to emu (emu/flux quantum units) in the z direction.
	pmag_response_x	SQUID response length in the x direction, in cm^3.
	pmag_response_y	SQUID response length in the y direction, in cm^3.
	pmag_response_z	SQUID response length in the z direction, in cm^3.

Paleomagnetics – PMAG		
Table Name	**Column Name**	**Column Comment**
PMAG_Demag_Type	pmag_demag_id	Unique Oracle-generated sequence number for each demagnetization type.
	pmag_demag_type	Abbreviation for method of demagnetization.
	pmag_demag_comment	Description of method of demagnetization.

PMAG_Treatment_ Type	pmag_treatment_id	Unique Oracle-generated sequence number for each treatment type.
	pmag_treatment_type	Abbreviation of treatment type.
	pmag_treatment_comment	Description of treatment type.

Leg	Leg	Number identifying the cruise for which data were entered into the database.
	description_of_area	General description of the area where the sites are located.
	objective	General objectives and accomplishments of leg.
	ops_area	Operating area for leg.
	total_miles_transited	Total miles transited during leg.
	total_miles_surveyed	Total miles surveyed during leg.
	average_speed_transit	Average transit speed for cruise.
	average_speed_survey	Average speed during surveys done on leg.
	reentry_count	Number of hole reentries performed during leg.
	datetime	Generic date/time.

Section	section_id	Unique Oracle-generated sequence number to identify each section. This is done because of the physical subsection / zero section problems. In adding new sections, deleting sections or changing sections - don't want to have to renumber.
	leg	Number identifying the cruise for which data were entered into the database.
	site	Number identifying the site from which the core was retrieved. A site is the position of a beacon around which holes are drilled.
	hole	Letter identifying the hole at a site from which a core was retrieved or data were collected.
	core	Sequential numbers identifying the cores retrieved from a particular hole. Cores are generally 9.5 meters in length, and are numbered serially from the top of the hole downward.
	core_type	A letter code identifying the drill bit/coring method used to retrieve the core.
	section_number	Cores are cut into 1.5 m sections. Sections are numbered serially, with Section 1 at the top of the core.
	section_type	Used to differentiate sections of core (S) from core catchers (C). Previously core catchers were stored as section number CC, but in Janus core catchers are given the next sequential number from the last section recovered.
	curated_length	The length of the section core material, in meters. This may be different than the liner length for the same section. Hard rock cores will often have spacers added to prevent rock pieces from damaging each other.
	liner_length	The original length of core material in the section, in meters. Sum of liner lengths of all the sections of a core equals core recovery.
	core_catcher_stored_in	Sometimes the core catcher is stored in a D tube with a section. core_catcher_stored_in contains the section number of the D tube that holds the core catcher.
	section_comments	Comments about this section.

Sample	sample_id	Oracle-generated sequence number that with *location* uniquely identifies a sample.
	location	Code that indicates the site where the Janus application is exercised. Values are SHI (ship), GCR (Gulf Coast Repository), ECR (East Coast Repository, WCR (West Coast Repository) and BRE (Bremen repository). Used with *sample_id* to uniquely identify a sample.
	s_c_leg	Number identifying the cruise for which data were entered into the database. Foreign key used with s_c_sampling_code to link samples with a scientist's sample request.
	s_c_sampling_code	Code used to identify samples taken for a sample request. Used with s_c_leg.
	sam_archive_working	Part of section sample was taken. Valid values: WR – whole round, A – archive half, W – working half.

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Table Name	**Column Name**	**Column Comment**
	top_interval	Distance in meters from the top of the section to the top of the sample.
	bottom_interval	Distance in meters from the top of the section to the bottom of the sample.
	piece	Additional identifier for hard rock samples. Each individual piece of rock within a section is numbered consecutively starting at the top of the section.
	sub_piece	Additional identifier for hard rock samples. When a piece is broken, the individual fragments are given consecutive letter designations. Note that subpiece assignments must be made in conjunction with piece numbers.
	beaker_id	The number on the moisture density beaker. Used for samples analyzed for moisture and density.
	volume	Volume of sample.
	entered_by	Indicates who entered the sample into the database.
	sample_depth	Depth of the sample
	sample_comment	Comment about the sample.
	sam_repository	Repository where sample was taken.
	sam_sample_code_lab	Code to indicate the shipboard lab that will perform the initial analysis.
	sam_section_id	Unique Oracle-generated sequence number to identify each section. This is a foreign key that links a sample to leg, site, hole, core, and section.
	timestamp	Timestamp when sample was entered into database. Samples taken before 11/1998 and migrated samples have datetime 11/25/1998 12:26PM.

System_Type	system_id	Unique identifier for a system of equipment used to collect data.
	system_comments	Comments associated with a piece of analytical equipment.
	system_commissioned	Date that a piece of equipment started to be used to collect scientific data for ODP.
	system_decommissioned	Date that a piece of analytical equipment was no longer used by ODP to analyzed samples for scientific data.
	system_model_number	The model number of a piece of equipment used for scientific analysis.
	system_name	The name for a piece of equipment used for analysis.

Appendix II. Description of data items in files

Item Name	Column Description and Calculations	Format
Leg	Number identifying the cruise. The ODP started numbering the scientific cruises of the *JR* at Leg 101. A leg was nominally two months duration. During the 18+ years of the ODP, there were 110 cruises on the *JR*.	Integer 3
Site	Number identifying the site. A site is the location where one or more holes were drilled while the ship was positioned over a single acoustic beacon. The *JR* visited 656 unique sites during the course of the ODP. Some sites were visited multiple times, including some sites originally visited during the Deep Sea Drilling Program for a total of 673 site visits.	Integer 4
Hole	Letter identifying the hole. Multiple holes could be drilled at a single site by pulling the drill pipe above the seafloor, moving the ship some distance away and drilling another hole. The first hole was designated 'A' and additional holes proceeded alphabetically at a given site. Location information for the cruise was determined by hole latitude and longitude. During ODP, there were 1818 holes drilled or deepened.	Text 1
Core	Cores are numbered serially from the top of the hole downward. Cored intervals are up to 9.7 m long, the maximum length of the core barrel. Recovered material was placed at the top of the cored interval, even when recovery was less than 100%. More than 220 km of core were recovered by the ODP.	Integer 3
Type	All cores are tagged by a letter code that identifies the coring method used.	Text 1
Section	Cores are cut into 1.5 m sections in order to make them easier to handle. Sections are numbered serially, with Section 1 at the top of the core. Most of the scientific measurements were made on sections or discrete samples taken from the sections. Samples and measurement intervals are given in centimeters from the top of each section.	Integer 2
Top (cm)	The top interval of a measurement in centimeters measured from the top of a section.	Decimal F4.1
Depth (mbsf)	Distance in meters from the seafloor to the sample location.	Decimal F7.3
Treatment	Type of treatment. For continuous cores, the only treatment was Natural Remanent Magnetization – NRM.	Text 20
Treatment Demag Level	The demagnetization level or biasing level of the treatment.	Decimal F5.1
Demag type	Type of demagnetization. For continuous measurements, the demag type was AFD – in-line Alternating Field.	Text 20
Demag level	Intensity of the demagnetization field.	Decimal F7.2
Declination	Orientation of the magnetic field of the sample (the field acquired at the time of the rock formation) - the angle between geographic north and the magnetic field direction (the magnetic azimuth). Recorded in degrees – 0.00 – 359.99	Decimal F5.2
Inclination	Orientation of the magnetic field of the sample (the field acquired at the time of the rock formation) - the angle between the horizontal and the field direction measured positive downward. Recorded in degrees, -90.00 – 90.00	Decimal F4.2
Intensity	Total intensity of the paleomagnetic field measurement, in Amperes/meter	Number 14

Item Name	Column Description and Calculations	Format
Hole Inclination	Inclination of the hole as determined from multishot or tensor tool analysis.	Decimal F6.2
Intensity X	North component of the horizontal intensity of the measured magnetic field, in Amperes/meter.	Number 14
Intensity Y	East component of the horizontal intensity of the measured magnetic field, in Amperes/meter.	Number 14
Intensity Z	Vertical component of the intensity of the measured magnetic field, in Amperes/ meter	Number 14
Run Number	Number generated by the data acquisition software, to identify an analysis run of a section of core.	Integer 6
Comment	General comments.	Text 40